

Casualty crash rates for Australian jurisdictions

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Abstract

There is a scarcity of information in Australia about casualty crash rates for various types of road environments. Over a six year period, ARRB carried out an extensive Austroads funded project to develop a geospatial crash database combining crash, road asset and traffic flow information from different Australian jurisdictions.

A wealth of crash related information was derived from the database, including casualty crash rates, crash cost rates (indicative of the cost of road trauma) and relative risks associated with travelling on different standards of roads. Key relationships between casualty crashes rates and known road safety factors were explored to demonstrate application of the database. These factors included: traffic volumes, intersection approach volumes, road hierarchy, terrain and time of day among others.

A number of database outputs have potential for practical application by assisting jurisdictions in road safety program development and monitoring. Other potential uses were identified and remain to be explored. ARRB is keen to ensure that researchers and road authorities are aware of this resource and its potential.

Keywords

Road safety, crash rates, crash costs, safety performance, relative risk, exposure, risk assessment, database

Introduction

Crash rates, i.e. number of crashes per unit of travel, are a recognised road safety indicator. They are significant inputs into road safety policy development, assessment of road trauma costs and economic evaluation. They may be used by practitioners for day-to-day monitoring of the road network safety.

There is a scarcity of information in Australia on casualty crash rates for various stereotypes of roads and intersections. Much of the existing knowledge in this area has been developed ad-hoc for specific purposes and remains unpublished. This project aimed to investigate and disseminate information on crash rates throughout Australia through creation of a nation-wide crash rates database.

During this six-year Austroads project ARRB collected crash data, traffic volume data and road feature information from most Australian jurisdictions to develop a nation-wide crash rates database. The database has produced a number of useful road safety indicators to date such as crash rates, relative risks, crash cost rates and relative costs for a range of road environments in each jurisdiction. Examples of other practical applications of the database have been produced. Overview of the project results is to be published in Turner et al. (1) in late 2008.

Methods

With assistance of Austroads member organisations, ARRB defined the aims and carried out the tasks involved in building a geospatial crash rates database capable of storing data from different jurisdictions.

Specific Aims

A shortlist of areas of interest was prepared and presented to the Austroads stakeholders. The respondents were requested to indicate the usefulness of the following:

- crash rates for different road and intersection stereotypes
- corresponding crash cost rates
- corresponding relative risks and relative costs
- a sample of crash rate functions, safety performance functions and other specific road safety indicators.

All of the proposed areas were seen as useful by the member authorities in road safety policy and program evaluation. Therefore, the project proceeded with the data acquisition and analysis along these lines, within the limits set by the availability of the source data.

Initial Development 2002-2005

The initial four years involved preparation of a pilot database, gathering and understanding of GIS coded road information from road authorities in different states. The database was developed gradually as several individual sub-databases in recognition of non-interchangeable definitions of data fields from different jurisdictions.

Each year, funding was available to acquire, process, check and analyse data sets from individual jurisdictions. The key element of the database was the geospatial coding of all included information. This way the detailed road inventory data could be matched with the locations of crashes and the available AADT information. The database design progress and results were reported back to jurisdictions annually to assist in their own management and use of crash data.

Development 2005-2008

Between 2005 and 2007 the database was gradually consolidated, expanded and reorganised to produce the first useful results. One jurisdiction was added to the database, as it developed a geo-coded crash database at that time. Other jurisdictions, where data was previously of poor quality or simply unavailable, were able to provide expanded road information data sets, and in particular the AADT information for various road segments. Several state-controlled crash data sets were again extended and updated during this stage to maintain currency of the database. This provided a nation-wide coverage, with exception of the Northern Territory.

Development Process

The method used to derive crash rates information required consolidation of road inventory, traffic and crash data spatially within a GIS application and extraction of this data to a database application to query crash rates and other indicators. ArcMap and MapInfo were the GIS applications used to consolidate data for this study and crash rate queries were created within Access databases.

In summary, the following tasks were performed in order to create the database:

- literature review on the subject to inform the methodology
- approach and data requests to all jurisdictions
- collection and processing of all road, crash and traffic volume data for each jurisdiction
- identification of a method for the annual update of databases with the latest crash data and AADT information
- development of custom query forms for enhanced data accessibility
- generation of crash rates information for all road and intersection stereotypes.

Crash rates for fatal crashes, serious and other injury crashes, property damage only (PDO)¹ crashes and for casualty crashes (i.e. combined fatal, serious and other injury crashes) were determined from the available data for each jurisdiction (Northern Territory GIS data was not available). The analysis and reporting was carried out for road midblock stereotypes (state-state road intersections excluded) and for

¹ PDO crashes were excluded from the paper due to the highly inaccurate nature of this variable.

state-state road intersection stereotypes. Further analysis was carried out to test for the influence of local intersections on the midblock crash rates.

Crash Rates

Crash rates indicate the likelihood of a casualty crash for a given road or intersection stereotype. Average crash rates were expressed in casualty crashes per unit of exposure. The calculations and terminology used in calculating crash rates for each chosen stereotype are shown in Table 1.

Table 1: Traffic volume and crash rate calculations

Information	Calculations
The Average Annual Daily Traffic (AADT) is a count of all vehicles travelling in both directions along a road during an average day. As the crash rates were determined over a five year period, the total traffic volumes were calculated over that period.	$\text{TrafVol (5yrs)} = \text{AADT} \times 365 \text{ days} \times 5 \text{ years} \quad (1)$
Crash rates for road midblocks were based on 100 million vehicle kilometres travelled (100M VKT).	$100\text{M VKT (5yrs)} = \text{TrafVol (5yrs)} \times \text{road length (km)} / 10^8 \quad (2)$
Crash rates for intersections were based on 10 million vehicles entering (10M VE). The sum of all leg traffic volumes was divided in two as only one traffic flow direction on each leg was entering the intersection (equal split was assumed). A standard approach of 100 m was applied on all state roads.	$10\text{M VE (5yrs)} = \text{Sum of all leg TrafVol (5yrs)} / 2 / 10^7 \quad (3)$
Midblock crash rates were based on the number of casualty crashes per 100M VKT.	$\text{Midblock crash rate} = \text{Crashes (5yrs)} / 100\text{M VKT (5yrs)} \quad (4)$
Intersection crash rates were based on the number of casualty crashes per 10M VE.	$\text{Intersection crash rate} = \text{Crashes (5yrs)} / 10\text{M VE (5yrs)} \quad (5)$

Road or intersection stereotypes were defined by either single or multiple attributes derived from the road inventory data. Thus, at the highest level, crash rates were derived for stereotypes defined by a single attribute, e.g.: rural, urban, undivided, divided, 3-leg intersections, 4-leg intersections, roundabouts, traffic signals, etc.

Then, these attributes were combined into logical sub-sets, e.g. rural-undivided, rural-divided, rural-3-leg intersection-roundabout, etc. Not all attributes were available for all jurisdictions or were directly comparable. For example, intersection type information was only provided in four of the six jurisdictions.

Many of the attributes varied in their definitions from one jurisdiction to another. To overcome this problem, some attributes were consolidated into standardised higher-level stereotype definitions for further analysis. Thus it was possible to report some basic attributes at a nation-wide level. In parallel, crash rates were also developed using only each jurisdiction's own attributes (part of forthcoming Austroads report).

Once crash rates were calculated, ratios of the casualty crash rates were calculated for each group of like stereotypes. These ratios were referred to as relative risks, as they indicated the likelihood of a casualty crash for one stereotype compared to the safest stereotype in the group. The following equation shows the calculation of relative risk for any given stereotype:

$$\text{Relative risk}_n = \text{Crash rate}_n / \text{Crash rate}_{(\text{lowest})} \quad (6)$$

Thus the stereotype with the lowest casualty crash rate was assigned a relative risk value of 1.00 and all other stereotypes had a value greater than 1.00.

Crash Cost Rates

Crash cost rates indicate the cost of road trauma and damage borne by the community as a result of road crashes. They contribute to a more comprehensive understanding of road safety performance by providing an economic platform for comparison between different road environments and different jurisdictions. Crash cost rates can be expressed in cents per VKT for midblocks, and in cents per VE for intersections.

Crash cost rates are considered a separate road safety performance indicator, and in this paper, they apply to different types of road infrastructure. They should be considered alongside other indicators to provide a full picture of road safety performance of the road transport system. Such indicators include: crash rates per vehicle-kilometres travelled, per unit of population or per unit of registered vehicles. Crash cost rates account for differing severity of crashes typically occurring in different road environments. For example, if two roads have similar casualty crash rates, the one with a higher crash cost rate will generally have more fatal and serious injury crashes. Such knowledge is crucial in evaluating the effectiveness of engineering road safety initiatives.

Casualty crash cost rates were calculated by applying the following equation for each chosen road or intersection stereotype:

$$\text{Crash cost rate} = \sum_i (\text{Crashes}_i \times \text{unit crash cost}_i) / \text{Exposure} \quad (7)$$

where:

- i = crash severity, i.e. fatal, serious injury, minor injury crash, or as per jurisdiction definitions.
- Crashes = number of crashes of i severity within all midblock segments or intersections belonging to a particular stereotype, over a five-year period.
- Exposure = sum of 100M VKT for all midblock segments, or sum of all 10M VE for all intersections, belonging to a particular stereotype.

The unit crash costs were obtained from the internal Austroads report by Perovic et al. (2). They were split by crash severities and by environment (urban/rural). The figures were a June 2007 review of earlier work by Bureau of Transport Economics (3). The process of estimating the unit crash costs accounted for such crash-related factors as: type of crash, average number and severity of casualties, funeral and medical costs, pain and suffering, productive contribution lost, vehicle repair costs, site clean-up costs and Police, legal and administrative costs.

Relative costs were calculated in a similar way to relative risks, with the lowest cost assigned a value of 1.00. Relative costs provided an easy to understand representation of the road trauma burden of different road or intersection stereotypes.

Results

The key results for this project were:

- casualty crash rates information for Australian jurisdictions
- examples of practical crash rates information available from the database.

Crash rates information was presented using the following means:

- crash rates in casualty crashes per 100M VKT for midblocks or per 10M VE for intersections
- crash cost rates in cents per VKT or per VE

- relative risks
- relative costs.

Casualty Crash Rates for Australian Jurisdictions

Due to the substantial differences in the way crashes and road data are recorded in different jurisdictions, a higher level of reporting was adopted to provide a common set of road and intersection stereotypes. Tables 2 and 3 present examples of crash rates information aggregated from jurisdiction level results (Northern Territory was excluded as GIS road data was not available).

Given the extensive nature of the database, it was not practical to show all possible analyses in this paper. Three tiers of crash rates information were produced:

- aggregated national overview figures (Tables 2 and 3)
- jurisdiction level figures (Appendix to this paper)
- jurisdiction level figures using the original attributes (to be published in an Austroads report).

Data provided by the authorities contained many different road and traffic attributes which allows further in-depth investigation of road safety relationships with the road environment. Such analysis can be facilitated in the future.

National Overview

The method used to combine crash rates from different jurisdictions was a weighted mean based on each jurisdiction's proportional contribution to the nation's road toll, sourced from BTE (3). The figures presented in Table 2 and Table 3 are aggregates and should not be compared with individual jurisdiction figures in the Appendix. The national figures could not account for varying levels of injury crash reporting in different jurisdictions.

The relative risk and relative cost figures are useful in presenting the picture of the relative safety of different road environments. Relative costs in particular reveal the previously hidden influence of severity of the crashes occurring in different road environments.

Table 2: National weighted mean of crash rates information – road midblock stereotypes

Road stereotype		Crash rate (casualty crashes per 100M VKT)	Relative risk	Crash cost rate (cents per VKT)	Relative cost
URBAN		23.69	1.60	4.74	1.00
RURAL		14.76	1.00	5.27	1.11
URBAN	SINGLE	29.44	2.91	5.84	1.87
URBAN	DIVIDED	16.95	1.68	3.47	1.11
RURAL	SINGLE	16.26	1.61	6.01	1.92
RURAL	DIVIDED	10.10	1.00	3.13	1.00

Table 3: National weighted mean of crash rates information – intersection stereotypes

Intersection stereotype		Crash rate (casualty crashes per 10M VE)	Relative risk	Crash cost rate (cents per VE)	Relative cost
URBAN		1.71	1.32	3.24	1.00
RURAL		1.30	1.00	4.11	1.27

URBAN	3 LEG	1.54	1.20	3.00	1.00
URBAN	4 LEG	1.98	1.54	3.75	1.25
RURAL	3 LEG	1.28	1.00	4.09	1.36
RURAL	4 LEG	1.73	1.35	7.06	2.35

URBAN	SIGNALS	1.22	1.38	2.41	1.26
URBAN	ROUNDABOUT	1.07	1.20	1.91	1.00
URBAN	OTHER*	0.93	1.05	2.22	1.16
RURAL	SIGNALS	1.08	1.22	2.81	1.48
RURAL	ROUNDABOUT	0.89	1.00	2.31	1.21
RURAL	OTHER*	0.99	1.12	3.81	2.00

* The term 'other' refers to intersections controlled by regulatory signage, i.e. Give Way signs, Stop signs, freeway on-ramp continuity lines, or traffic regulations (T-intersections). The actual proportions of these within each 'other' stereotype were not known for all jurisdictions.

The above figures are only an example of what can be obtained from the database. The Appendix presents crash rates information by jurisdiction using the same standardised road and intersection stereotypes as above.

The above results suggest that on average the social cost of casualty crashes was about 5 cents per each kilometre travelled. It was more than 10% higher in rural areas than in urban areas, even if the actual likelihood of being involved in a casualty crash (crash rate) was lower. More in-depth analysis confirmed that rural single carriageway roads had consistently higher fatal crash rates than any other road stereotype investigated. This contributed to the higher social costs of road trauma on rural roads. For every vehicle entering an intersection, there was an underlying 3-4 cents cost associated with casualty crashes. To appreciate this burden of casualty crashes on Australian road users, the above crash cost rates should be considered in the context of 19.5 cents per kilometre cost of running a medium size car as suggested by a 2008 review by Royal Automobile Club of Victoria (4).

Based on the calculated crash cost rates, the safest road midblock stereotype was found to be a divided rural road, followed closely by a divided urban road. The lowest intersection crash rate was attributed to rural roundabouts; however, the crash cost rate suggested that the urban roundabout resulted in lower overall cost due to reduced crash severity. The intersection stereotype with the highest crash rate was urban traffic signals.

Providing the mean crash rates information in Tables 2 and 3 was only one of the benefits of the nationwide crash database. The other key benefit was the opportunity to interrogate the crash data and to present safety performance indicators which could be of use to road safety program managers, road network planners, road designers and traffic engineers. The following sub-sections present examples of some of the practical indicators arising from the database. While these examples concentrate primarily on AADT as an independent variable, there are many other relationships which can be explored on demand.

Examples of Practical Application

Crash Rate Functions

Crash rate functions (CRFs) are an example of measuring the influence of traffic flow on the likelihood of crashes. CRFs are based on plots of crash rates of homogenous road midblock (or intersection) groups operating at similar AADTs. Analysis of crash data from different jurisdictions suggested that for midblock road segments of the same type the crash rate remains fairly constant or decreases across the AADT range. Figure 1 shows a Queensland example based on undivided urban arterials. A significant variation in crash rates at volumes >20,000 vpd suggests that crash performance on some multilane undivided roads may be subject to additional influencing factors.

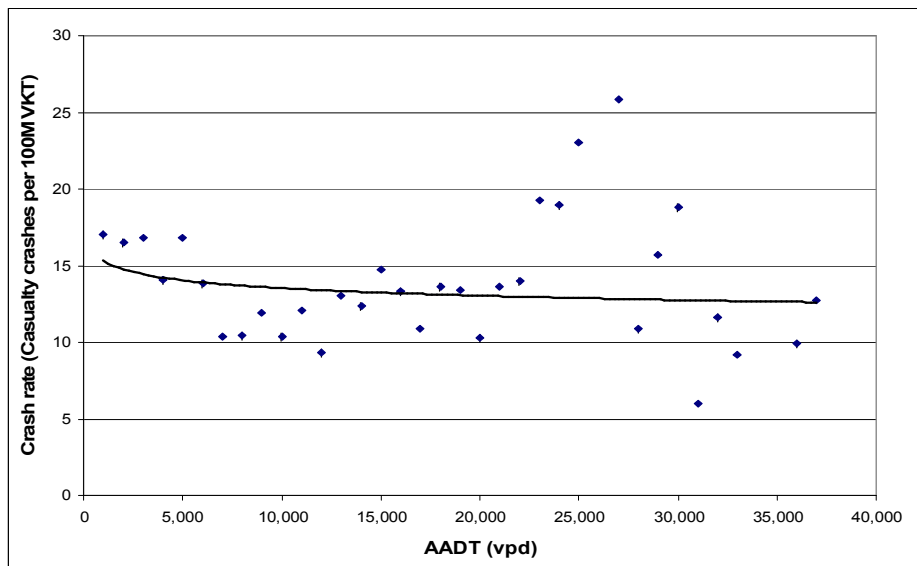


Figure 1: Crash rate function for undivided urban arterials in Queensland

Another example, in Figure 2 shows the effect the number of entering vehicles had on crash rates at 3-leg rural intersections in Victoria.

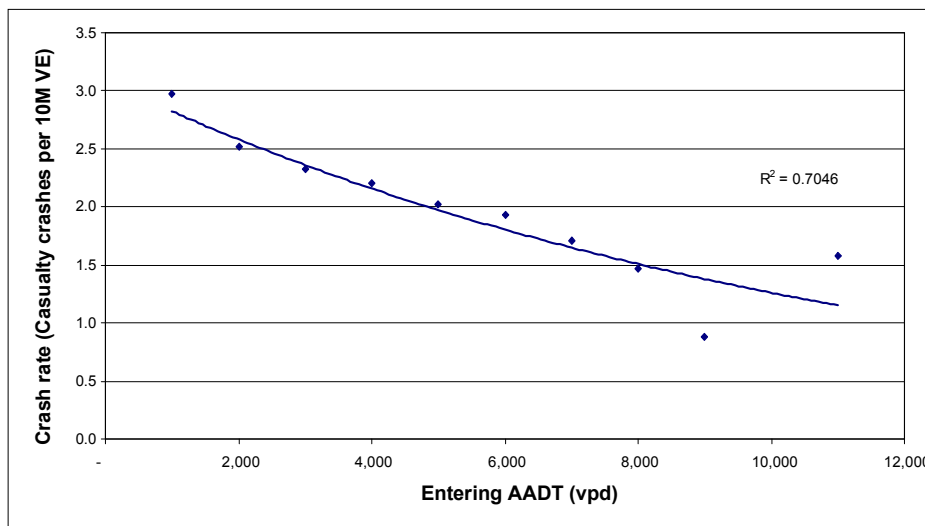


Figure 2: Crash rates across the AADT range for 3-leg unsignalised rural arterial intersections in Victoria

While most crash rates investigated in this project were found to remain reasonably unaffected by the AADT (i.e. close to the published mean), there were a number of exceptions as shown in Figure 2. Development of CRFs is therefore an important tool for understanding of safety performance of different road network elements operating under different traffic conditions.

Safety Performance Functions

An even more useful tool was the safety performance function (SPF). Instead of dealing with the crash rate, i.e. an average expected number of crashes per unit of exposure, the SPF presents the crash frequency – average number of crashes per kilometre (or per intersection) over a five year period vs. the AADT. In other words, average crash rate is the mean gradient of the SPF function.

This format is more immediately useful to practitioners involved in road safety program development or management. Using the Victorian 3-leg rural unsignalised intersections again as an example scenario, Figure 3 shows the expected number of crashes over a five year period for a given entering flow AADT (sum of all entering flows). Four immediate uses of such a function come to mind:

- monitoring of crash performance, e.g. is a 'problem' intersection reported by the public above or below the mean for the given AADT (seek action if it is above)
- for adjusting the expected crash reduction of treatments when they result in increased traffic volumes
- as a broad indicator of the expected crash numbers should the traffic flow increase over time
- in risk assessment models.

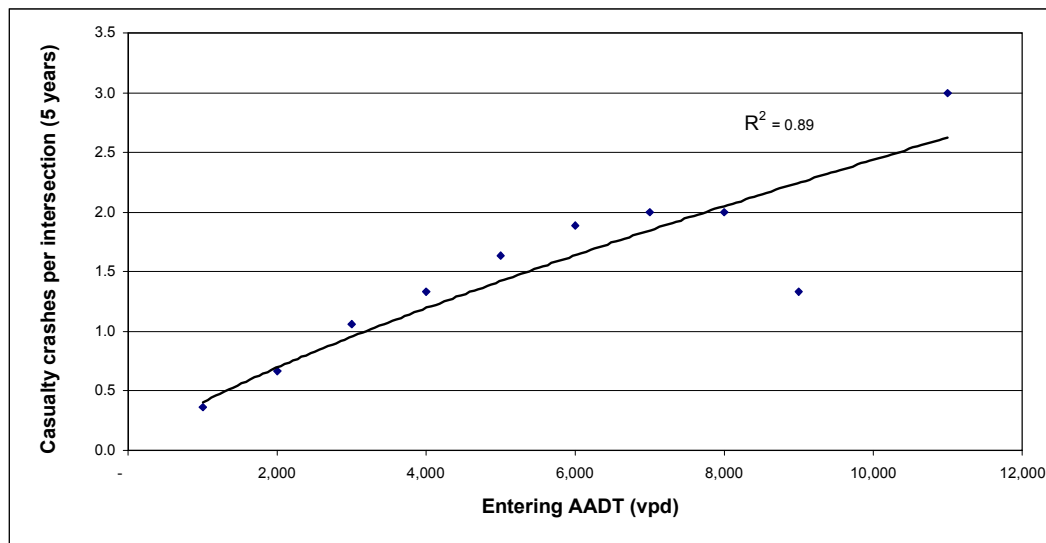


Figure 3: Average 5-year crash frequency at 3-leg unsignalised rural arterial intersections in Victoria

Influence of Major/Minor Intersection Traffic Flows

Measurement of traffic exposure at intersections is more complex than at midblocks due to traffic flows arriving from several different approaches. The key issue is the conflict between opposing traffic movements. An optimal way of accounting for exposure to crash risk is crucial for estimation of crash rates and crash cost rates at intersections.

The crash rates database design allowed investigation of major and minor flows on the frequency of casualty crashes. Figure 4 shows an example of such analysis for urban 4-leg signalised intersections in Victoria. This approach can be easily developed into a regression model and used for crash prediction. Such knowledge may be of use in arterial road planning, e.g. in balancing the frequency of arterial road intersections with the traffic flow on the side roads.

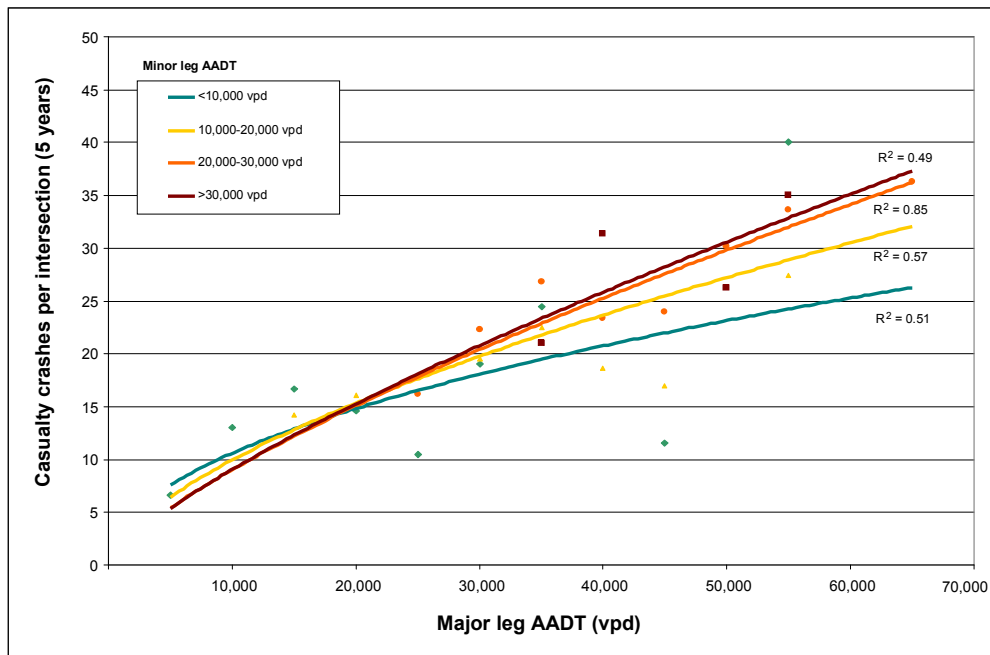


Figure 4: Change in crash frequency at different major and minor intersection leg flows

Influence of Road Hierarchy

The database structure allowed examination of the relative safety of different road hierarchy stereotypes. Crash performance of undivided rural road segments in South Australia was analysed according to each segment’s reported road hierarchy classification. A series of SPFs for different roads in the rural hierarchy are shown in Figure 5.

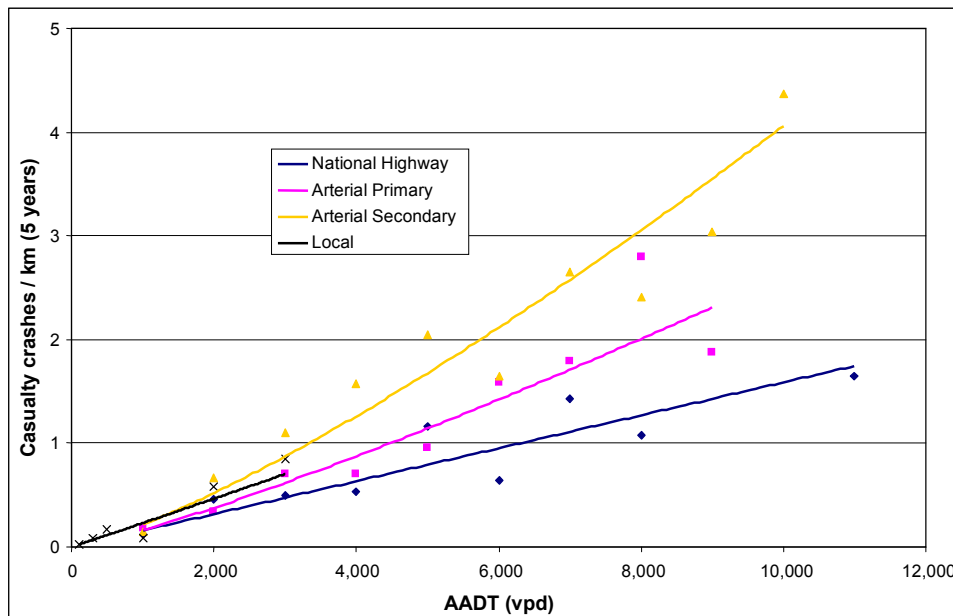


Figure 5: Casualty crash frequency of rural undivided roads in South Australia, by hierarchy

The National Highway category had the lowest crash frequency at high traffic volumes, whereas the Arterial Secondary had a substantially higher crash frequency at the same traffic flows. This confirmed the common belief that roads on which traffic outgrows their intended function become less safe. This may be assumed to be related to the engineering standard differences between the road stereotypes, issues such as alignment, delineation and presence of sealed shoulders.

Influence of Terrain

As an example of applying the road inventory data for crash rate analysis, the NSW crash data was used to produce an SPF for different types of terrain for undivided urban roads. Figure 6 shows the results for such roads in flat and undulating terrain. The AADT range was truncated at 20,000 vpd to provide clearer results (an approximate capacity of undivided two-lane urban roads). Multilane undivided roads appear above that value and provide a different relationship.

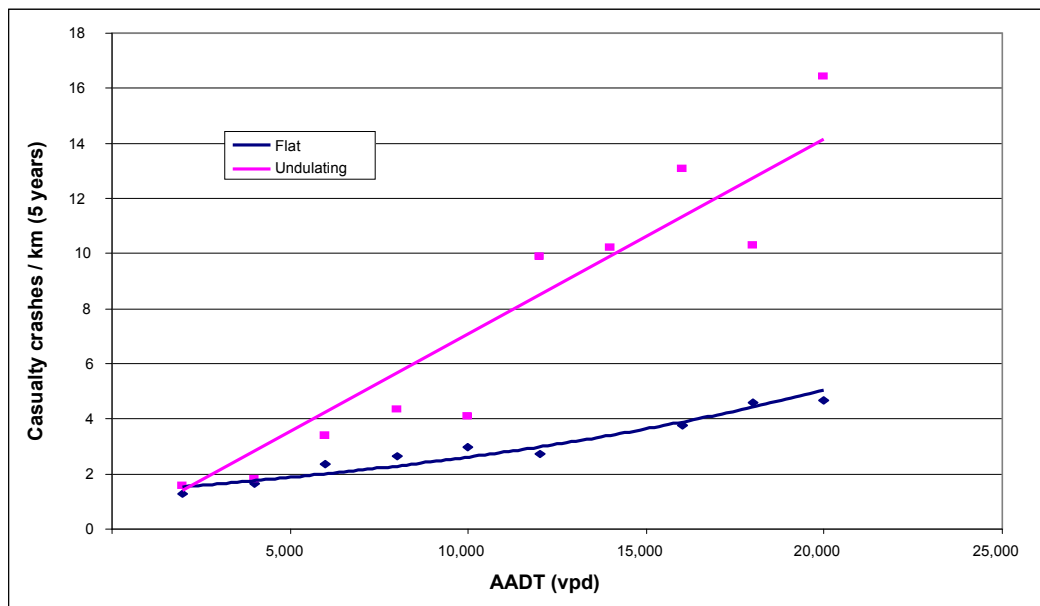


Figure 6: Crash frequency for different terrains for undivided urban arterial roads, based on NSW data

Influence of Time of Day

In-depth analysis of jurisdiction casualty crash details contained in the database allowed development of crash rate graphs by time of day. Time of day is a proxy for traffic congestion (peak/off-peak) and road user behaviour (higher speeds at night, intoxication). Analysis of the crash rates rather than crash frequencies was carried out to account for the different traffic flows at different times.

Figures 7 and 8 illustrate the changes in crash rates for road midblocks and intersections, based on Victorian data. It is worth noting, that the crash rates were highest during the day-time off-peak period. Possible causes for this include the combination of higher average speeds, commercial activity and increased presence of pedestrians. Analysis of crash costs would provide further insight into the impact of the time of day on road trauma. This could be a subject of future analysis.

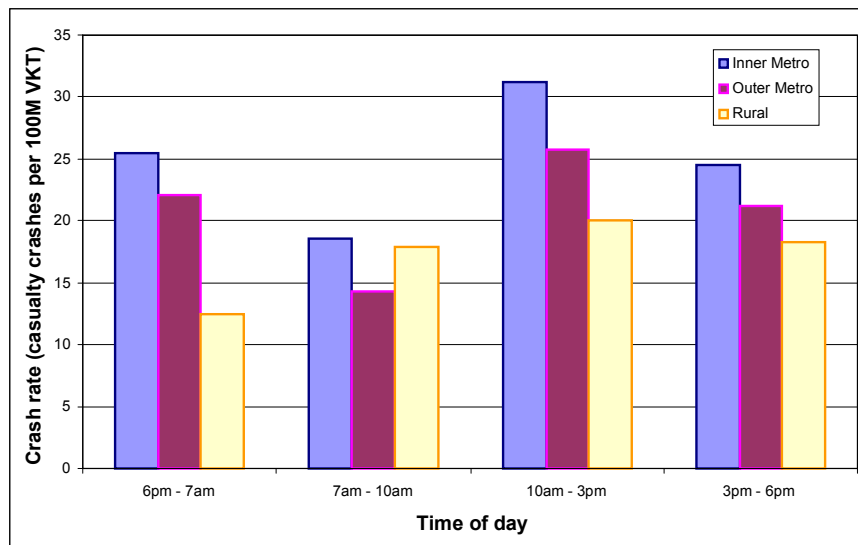


Figure 7: Average crash rates for midblock road sections based on the time of day (Victorian data)

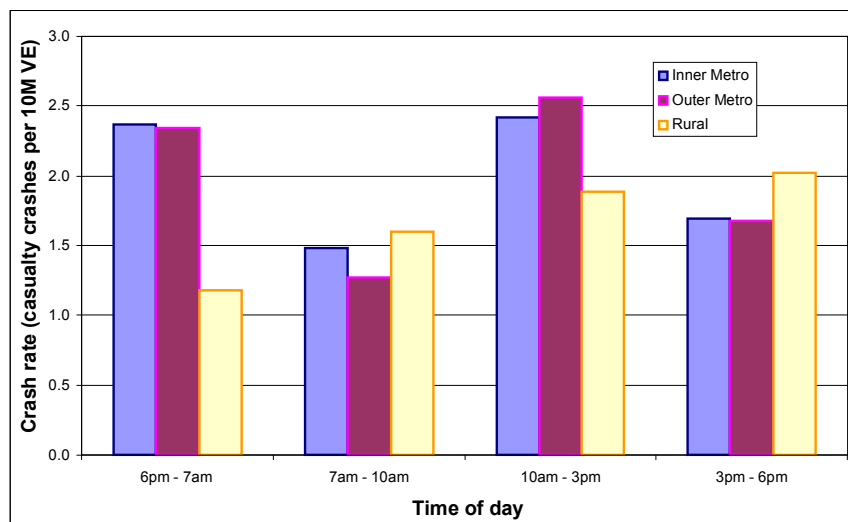


Figure 8: Average crash rates for intersections based on the time of day (Victorian data)

Analysis of Crash Types

Selected crash types can be analysed as a function of the traffic flow across the network or for a particular road or intersection stereotype. Figure 9 shows an SPF for head-on crashes. It is clear that the frequency of crashes strongly increases with the traffic flow (R^2 of 0.96). Figure 10 shows that the crash rate was relatively independent of the AADT (R^2 of only 0.19), typical of general midblock CRF results.

Development of a specific-use SPF relationship (e.g. head-on crashes, run-off-road crashes, wet weather crashes, etc.) may assist jurisdictions in improved analysis of their road network elements by introducing an exposure sensitivity. Practitioners may use the regression equation to check if a series of crashes observed at one location is in fact below or above the expected value. Such insight may prove useful in decisions about further investigation and project funding.

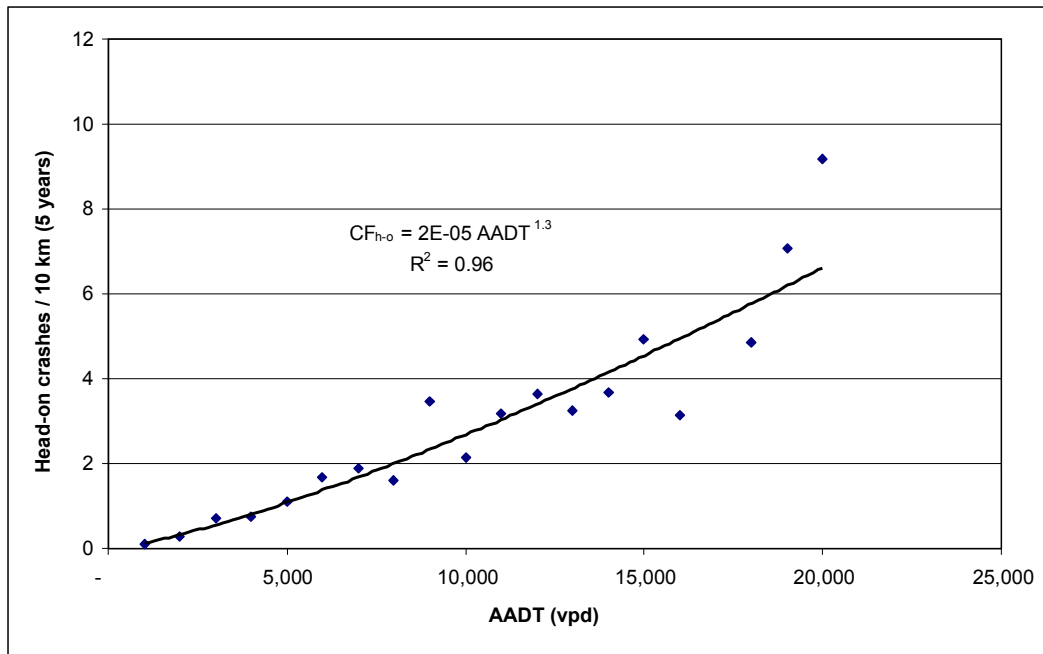


Figure 9: Expected head-on crashes frequency based on Victorian data for undivided rural arterial roads

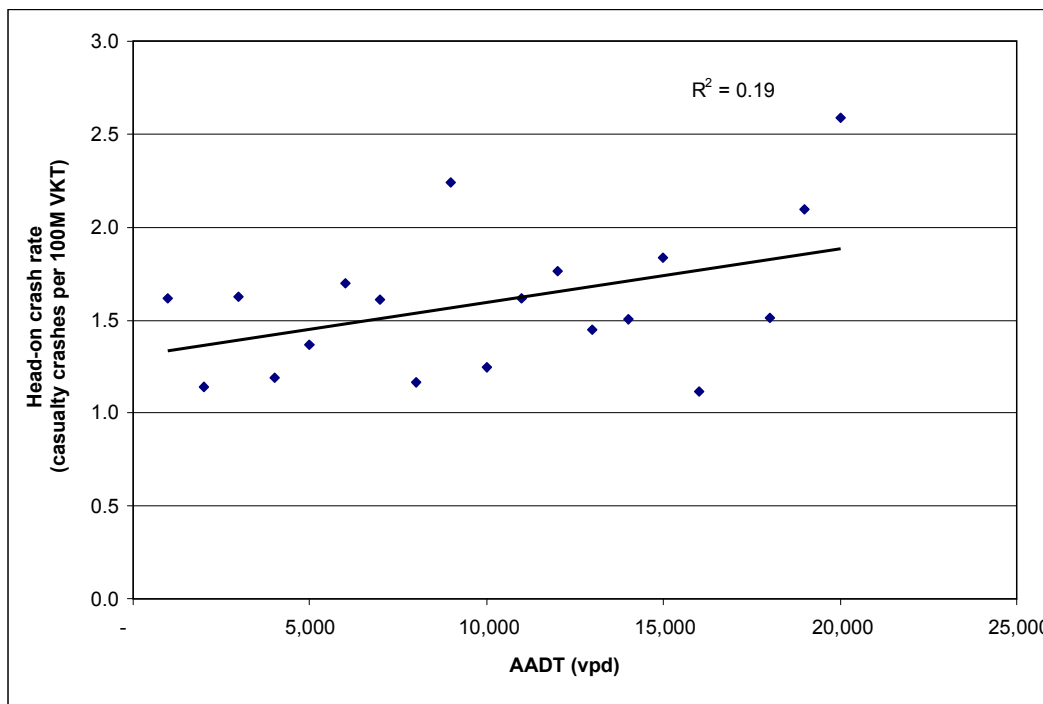


Figure 10: Expected head-on crash rate based on Victorian data for undivided rural arterial roads

Relative Risk Functions

Many design guidelines and risk assessment methods utilise the relative risk to express the changing likelihood of casualty crashes as a result of a particular feature. Any of the above crash rate functions could be easily converted into a risk function by taking the lowest crash rate as the baseline risk of 1.0

and using it as a ratio denominator. Figure 11 shows an example how the risk of a casualty crash decreases with increasing flow.

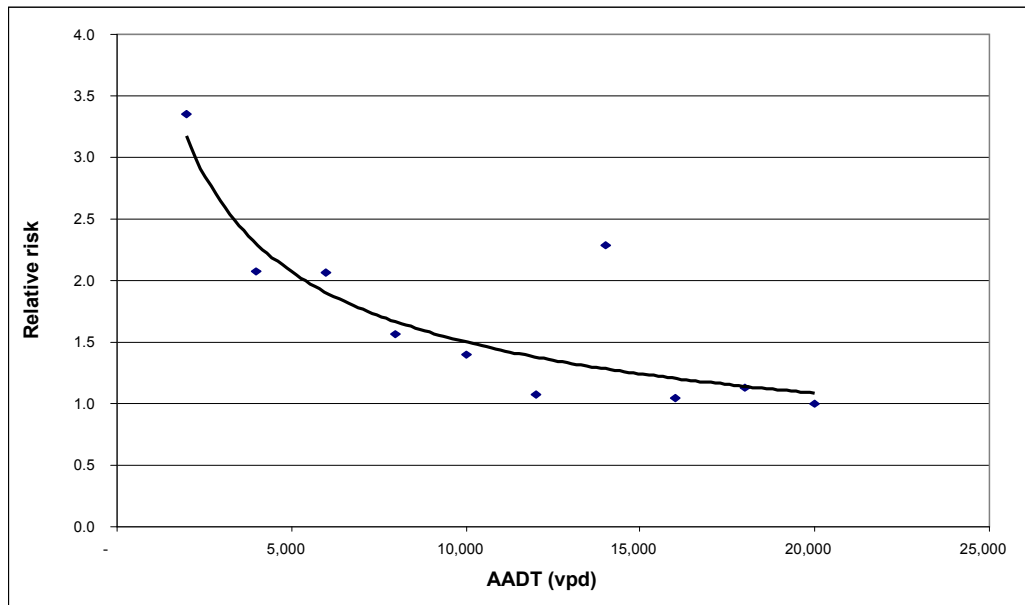


Figure 11: Relative crash risks for undivided urban arterial roads in NSW (flat terrain) vs. AADT

Influence of Local Intersection Crashes on Midblock Crash Rates

The data held by jurisdictions generally contained the traffic flow information for the state-controlled road network. Local road traffic and GIS information was either missing or was held by the local governments and was thus unavailable. Hence, state-local road intersections had to be ignored in the midblock crash rate calculations and any crashes occurring at such locations were included in the midblock sample. This practice is common in crash rate analysis literature. Nevertheless, the influence of state-local intersections was suspected to be significant, particularly in the urban environments.

Engineering ‘folklore’ suggested that in urban environments, road midblock segments have relatively few crashes and that most crashes occur at either state-state road intersections or at state-local road intersections.

The crash rates database allowed this hypothesis to be tested by separating the influence of state-local road intersections on the midblock crash rates. This was achieved by filtering out from the midblock crashes sample any crashes spatially identified by Police as occurring within 10 m of an intersection. Those crashes that remained in the sample were thus identified as true midblock crashes. Figure 12 illustrates the significant difference in the crash rates when all state-local road intersection crashes have been removed.

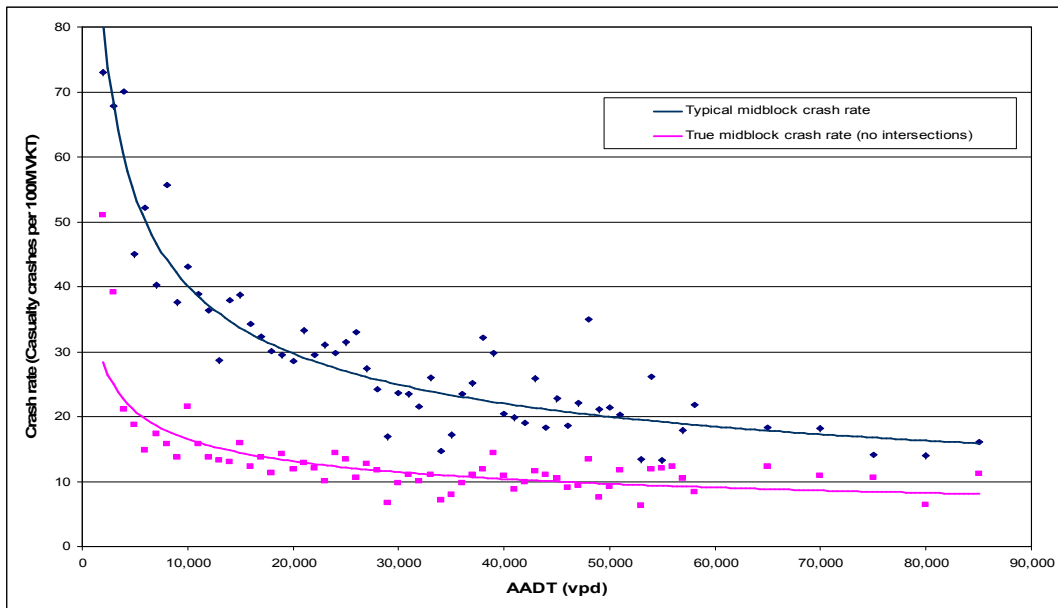


Figure 12: The difference in crash rates due to presence of state-local intersections, based on Victorian data from undivided urban arterial roads

Figure 12 shows that approximately half of the midblock crash rate can be attributed to the state-local road intersections for this midblock stereotype. The picture is even clearer on the SPF from the same data set shown in Figure 13, which suggests that more than 50% of the midblock crashes can be attributed to the intersections with local roads.

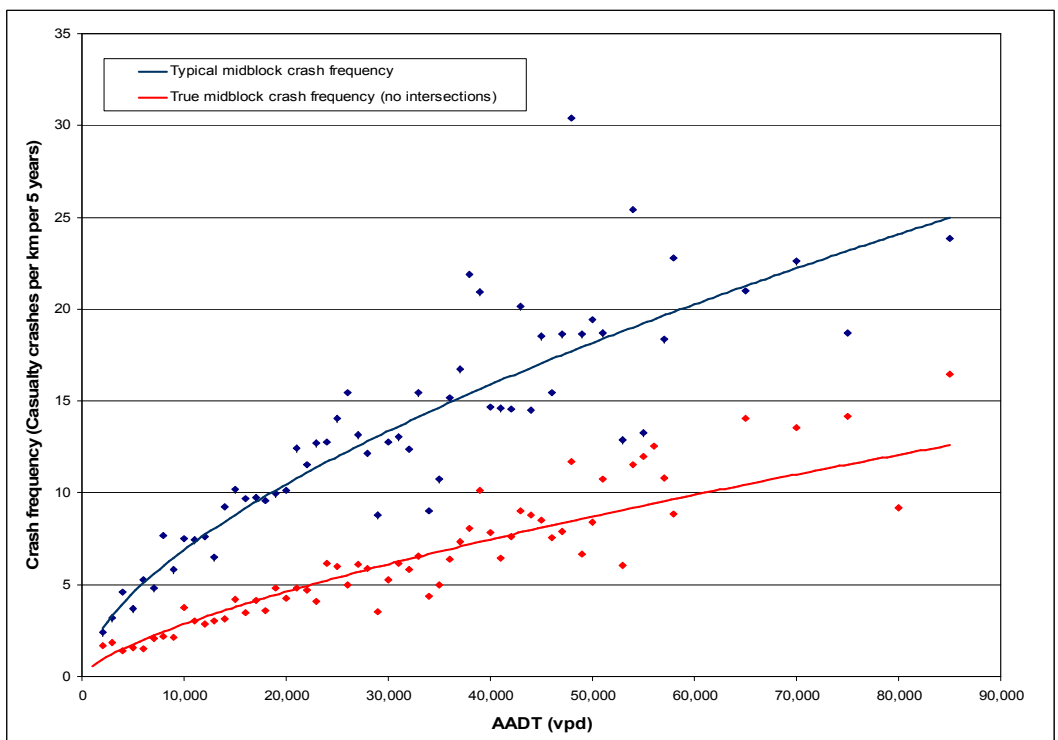


Figure 13: The difference in crash frequency due to presence of state-local intersections, based on Victorian data from undivided urban arterial roads

Analysis of Accuracy

The SPFs and CRFs present mean values for small AADT ranges. The results can be subjected to rigorous error analysis to provide an indication of their robustness. While a detailed review of different error analysis methods is a subject for another project, the authors chose one of the simplest applicable methods to provide an example of the accuracy of the information derived from the crash rates database.

Along with estimating the crash rate as a single value, an interval likely to include that value can also be given. Thus the 95% confidence interval (95CL) is described by the upper and lower bound values between which there is a 95% chance of finding the true mean value. The narrower the interval, the more reliable the value is. In case of the Poisson distribution (applicable to crash events) the 95% interval of the crash rate may be represented simply as:

$$95CL = \pm 1.96 (\text{number of crashes})^{0.5} / \text{Exposure} \quad \text{from the mean value} \quad (8)$$

The example from Figure 2 can be re-plotted showing the upper and lower bounds of the results, as shown on Figure 14. As it can be observed, the relationship begins to break down at the higher traffic volumes – the 95CL spans the zero. This is usually a sign that the number of crashes in the sample is too low to provide robust crash rate information.

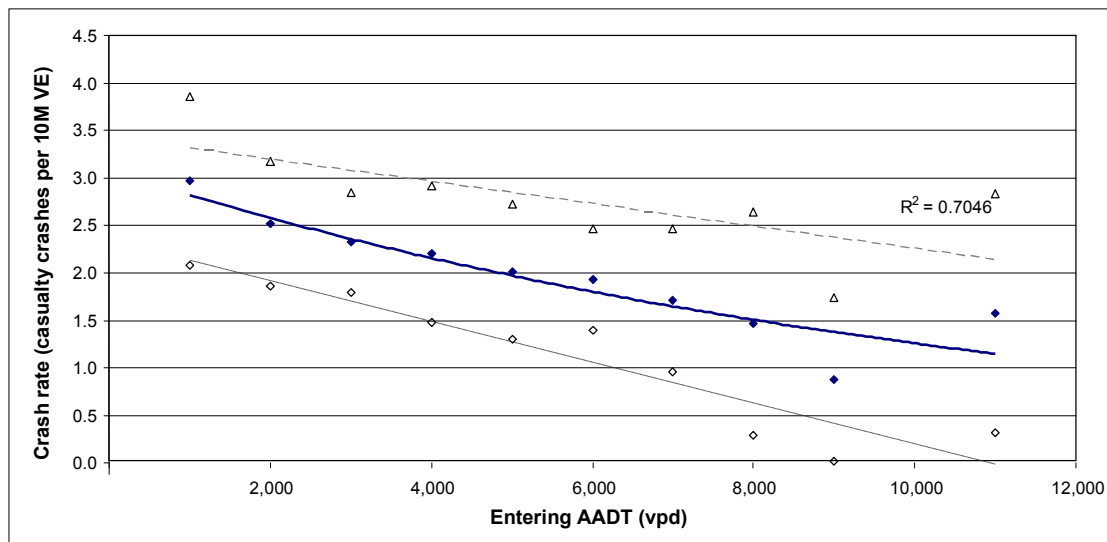


Figure 14: The 95% confidence interval for a crash rate function for 3-leg unsignalised rural intersections in Victoria

Discussion

The crash rate information (crash rates, crash cost rates, relative risks and relative costs) obtained varied from state to state. Though none of the jurisdictions could provide a full set of traffic flow data for the entire state road network, the coverage for each of the jurisdictions was large enough to have confidence in most of the rates for stereotypes defined by the attributes in Tables 2 and 3 and in the Appendix.

The differences in the data sources, road attributes and their definitions, and in extraction methods should be kept in mind when comparing crash rate information results. Examples of these variations are as follows:

- the percentage of the total road network included in the data sets, road attributes and traffic volume coverage across each jurisdiction
- different classification of roads across jurisdictions
- different classification of crash severities

- different reporting rates between jurisdictions, especially for injury crashes
- environment classification as urban, outer urban or rural varied between jurisdictions; some had to be assumed on the basis of speed limit due to lack of other information
- traffic volume records and/or estimates – some jurisdictions had up-to-date data, others provided updated estimates based on old counts.

These variations in the data made it too difficult at this stage to integrate the jurisdiction data into a central Australian database. The task of consolidating the road and crash information at a national level is possible and should be considered as a strategic long-term project with benefits for road infrastructure planning and road safety policy at state and national levels. In particular, development of a KSI index (killed and seriously injured) similar to that used in the UK would be of key importance in monitoring the progress towards the 'safe system' in road transport, the aim of the National Road Safety Strategy.

A step toward achieving a national uniformity of crash rates would be an audit of the fatal and injury under-reporting levels in each jurisdiction and development of appropriate adjustment factors for each jurisdiction. There has been no recent in-depth Australian research in this field.

It was decided not to include property damage only (PDO) crash rates in this paper. The under-reporting rates were known to be very high. The crash reporting requirements also varied between jurisdictions (e.g. the estimated cost of damage requiring reporting). For those reasons, this useful severity category could not be reported or compared accurately.

Analysis carried out as part of the project highlighted an ongoing issue with crash and road data availability. Most jurisdiction data sets allowed only limited analysis of factors influencing road safety performance.

In analysis of intersection crash rates information, only the intersections for which traffic volumes were known on all legs were included in the sample. Thus, for some jurisdictions the sample size for intersections was lower than desired due to lack of traffic flow data.

Reporting of crash information across Australian jurisdictions appeared to decline over the duration of the project. One jurisdiction combined the reporting of serious and minor injuries into one category. Two other jurisdictions experienced reporting delays of 12-18 months. Unavailability of up-to-date and reliable crash information will impact the future monitoring of road safety performance and may lead to wrong conclusions regarding the economic benefits of road safety programs. It should be noted, however, that the road asset information has generally improved over the duration of the project.

There are numerous opportunities to further utilise and develop the crash rates database. Some of the areas where further uses and developments have been identified are:

- use of relative risks in risk assessment models and programs
- geo-spatial analysis of crash costs, e.g. combined with socio-economic factors, climatic conditions, road expenditure, maintenance, etc
- development of multi-variable crash prediction models so that safety consequences of engineering changes can be appreciated before funding decisions are made
- in road safety policy development – to target issues or areas of poor crash performance
- development and economic evaluation of road safety programs
- Road Safety Impact Statement / Assessment methods
- improved monitoring of the progress towards the goals of the National Road Safety Strategy.

References

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APPENDIX

The appendix shows the second tier of presented crash rates information – the high level attributes by jurisdiction. At this level of reporting, several stereotypes suffered from small sample size which affected the accuracy of the results. A large 95% confidence interval indicates that the result is not robust. The same can be concluded if the lower end of the confidence interval falls below the zero.

New South Wales

The following crash rates have been produced for New South Wales. Greater detail of attributes and results exists within the database. It is possible to perform more specific analysis on request.

Table A1: New South Wales crash rates – road midblock stereotypes

Road stereotype		Crash rate (casualty crashes per 100M VKT)	95% confidence interval	Relative risk	Crash cost rate (cents per VKT)	Relative cost
URBAN		29.37	(29.06; 29.68)	2.29	5.77	1.41
RURAL		12.82	(12.57; 13.07)	1.00	4.08	1.00

URBAN	SINGLE	35.89	(35.33; 36.45)	3.37	7.12	2.46
URBAN	DIVIDED	25.58	(25.22; 25.94)	2.40	4.99	1.73
RURAL	SINGLE	13.44	(13.15; 13.73)	1.26	4.42	1.53
RURAL	DIVIDED	10.65	(10.17; 11.13)	1.00	2.89	1.00

Table A2: New South Wales crash rates – intersection stereotypes

Intersection stereotype		Crash rate (casualty crashes per 10M VE)	95% confidence interval	Relative risk	Crash cost rate (cents per VE)	Relative cost
URBAN		1.49	(1.45; 1.53)	1.51	2.66	1.06
RURAL		0.99	(0.87; 1.11)	1.00	2.52	1.00

URBAN	3 LEG	1.50	(1.45; 1.55)	1.69	2.65	1.06
URBAN	4 LEG	1.46	(1.39; 1.53)	1.64	2.67	1.07
RURAL	3 LEG	1.00	(0.88; 1.12)	1.12	2.49	1.00
RURAL	4 LEG	0.89	(0.45; 1.33)	1.00	2.86	1.15

Victoria

The crash rates information for Victoria was extended by inclusion of intersection control stereotypes. Greater detail of attributes and results exists within the database. It is possible to perform more specific analysis on request.

Table A3: Victorian crash rates – road midblock stereotypes

Road stereotype		Crash rate (casualty crashes per 100M VKT)	95% confidence interval	Relative risk	Crash cost rate (cents per VKT)	Relative cost
URBAN		23.22	(22.92; 23.52)	1.42	4.25	1.00
RURAL		16.31	(15.95; 16.67)	1.00	4.87	1.15
URBAN	SINGLE	32.12	(31.69; 32.55)	5.77	5.84	5.26
URBAN	DIVIDED	5.57	(5.32; 5.82)	1.00	1.11	1.00
RURAL	SINGLE	18.57	(18.14; 19.00)	3.33	5.71	5.14
RURAL	DIVIDED	8.65	(8.11; 9.19)	1.55	2.05	1.85

Table A4: Victorian crash rates – intersection stereotypes

Intersection stereotype		Crash rate (casualty crashes per 10M VE)	95% confidence interval	Relative risk	Crash cost rate (cents per VE)	Relative cost
URBAN		2.01	(1.96; 2.06)	1.27	3.01	1.00
RURAL		1.58	(1.44; 1.72)	1.00	3.66	1.22
URBAN	3 LEG	1.87	(1.80; 1.94)	1.26	2.80	1.00
URBAN	4 LEG	2.11	(2.04; 2.18)	1.43	3.16	1.13
RURAL	3 LEG	1.60	(1.42; 1.78)	1.08	4.07	1.45
RURAL	4 LEG	1.48	(1.27; 1.69)	1.00	2.93	1.05
URBAN	SIGNALS	2.04	(1.99; 2.09)	1.39	3.02	2.03
URBAN	ROUNDABOUT	1.50	(1.31; 1.69)	1.02	1.49	1.00
URBAN	OTHER	1.86	(1.72; 2.00)	1.27	3.38	2.27
RURAL	SIGNALS	1.47	(1.28; 1.66)	1.00	2.57	1.72
RURAL	ROUNDABOUT	1.71	(1.33; 2.09)	1.16	2.68	1.80
RURAL	OTHER	1.69	(1.46; 1.92)	1.15	5.49	3.68

Queensland

The following crash rates information have been produced for Queensland. Greater detail of attributes and results exists within the database. It is possible to perform more specific analysis on request.

Table A5: Queensland crash rates – road midblock stereotypes

Road stereotype		Crash rate (casualty crashes per 100M VKT)	95% confidence interval	Relative risk	Crash cost rate (cents per VKT)	Relative cost
URBAN		12.80	(12.24; 13.36)	1.00	5.38	1.00
RURAL		13.43	(13.02; 13.84)	1.05	7.04	1.31
URBAN	SINGLE	13.38	(12.59; 14.17)	1.56	5.73	1.31
URBAN	DIVIDED	12.19	(11.41; 12.97)	1.42	5.02	1.15
RURAL	SINGLE	15.28	(14.76; 15.8)	1.78	8.06	1.84
RURAL	DIVIDED	8.59	(7.96; 9.22)	1.00	4.38	1.00

Table A6: Queensland crash rates – intersection stereotypes

Intersection stereotype		Crash rate (casualty crashes per 10M VE)	95% confidence interval	Relative risk	Crash cost rate (cents per VE)	Relative cost
URBAN		1.55	(1.26; 1.84)	1.00	5.9	1.00
RURAL		1.80	(1.51; 2.09)	1.16	9.34	1.58
URBAN	3 LEG	1.45	(1.14; 1.76)	1.00	5.62	1.00
URBAN	4 LEG	2.00	(1.24; 2.76)	1.38	7.10	1.26
RURAL	3 LEG	1.69	(1.41; 1.97)	1.17	8.67	1.54
RURAL	4 LEG	4.29	(2.12; 6.46)	2.96	24.76	4.41
URBAN	SIGNALS	1.89	(1.27; 2.51)	1.36	6.54	1.17
URBAN	ROUNDABOUT	1.67	(0.76; 2.58)	1.20	6.13	1.10
URBAN	OTHER	1.39	(1.05; 1.73)	1.00	5.59	1.00
RURAL	SIGNALS	2.32	(2.05; 2.59)	1.67	8.56	1.53
RURAL	ROUNDABOUT	1.47	(0.60; 2.34)	1.06	6.72	1.20
RURAL	OTHER	1.83	(1.53; 2.13)	1.32	9.59	1.72

South Australia

The following crash rates information was produced for South Australia. Greater detail of attributes and results exists within the database. It is possible to perform more specific analysis on request.

Table A7: South Australian crash rates– road midblock stereotypes

Road stereotype		Crash rate (casualty crashes per 100M VKT)	95% confidence interval	Relative risk	Crash cost rate (cents per VKT)	Relative cost
URBAN		35.35	(34.66; 36.04)	1.92	3.90	1.00
RURAL		18.37	(17.83; 18.91)	1.00	5.68	1.46
URBAN	SINGLE	44.64	(43.11; 46.17)	4.53	5.05	2.11
URBAN	DIVIDED	32.10	(31.33; 32.87)	3.26	3.5	1.46
RURAL	SINGLE	21.96	(21.26; 22.66)	2.23	7.07	2.96
RURAL	DIVIDED	9.85	(9.13; 10.57)	1.00	2.39	1.00

Table A8: South Australian crash rates – intersection stereotypes

Intersection stereotype		Crash rate (casualty crashes per 10M VE)	95% confidence interval	Relative risk	Crash cost rate (cents per VE)	Relative cost
URBAN		2.42	(2.35; 2.49)	1.74	2.27	1.00
RURAL		1.39	(1.27; 1.51)	1.00	3.28	1.44
URBAN	3 LEG	1.90	(1.81; 1.99)	1.43	1.92	1.00
URBAN	4 LEG	2.82	(2.72; 2.92)	2.12	2.56	1.33
RURAL	3 LEG	1.33	(1.20; 1.46)	1.00	3.23	1.68
RURAL	4 LEG	1.67	(1.34; 2.00)	1.26	3.57	1.86
URBAN	SIGNALS	2.65	(2.57; 2.73)	2.35	2.45	1.74
URBAN	ROUNDABOUT	3.05	(2.63; 3.47)	2.70	2.56	1.82
URBAN	OTHER	1.22	(1.10; 1.34)	1.08	1.41	1.00
RURAL	SIGNALS	1.95	(1.37; 2.53)	1.73	3.73	2.65
RURAL	ROUNDABOUT	1.13	(0.74; 1.52)	1.00	2.16	1.53
RURAL	OTHER	1.36	(1.23; 1.49)	1.20	3.34	2.37

Western Australia

An example of crash rates information derived from the database is provided below. Greater detail of attributes and results for Western Australia exists within the database. It is possible to perform more specific analysis on request.

Table A9: Western Australia crash rates – road midblock stereotypes

Road stereotype		Crash rate (casualty crashes per 100M VKT)	95% confidence interval	Relative risk	Crash cost rate (cents per VKT)	Relative cost
URBAN		21.81	(20.93; 22.69)	1.53	3.61	1.00
RURAL		14.29	(13.86; 14.72)	1.00	5.75	1.59
URBAN	SINGLE	24.72	(23.28; 26.16)	1.80	4.26	1.37
URBAN	DIVIDED	19.64	(18.53; 20.75)	1.43	3.12	1.00
RURAL	SINGLE	13.72	(13.18; 14.26)	1.00	6.21	1.99
RURAL	DIVIDED	15.17	(14.46; 15.88)	1.11	5.04	1.62

Table A10: Western Australia crash rates – intersection stereotypes

Intersection stereotype		Crash rate (casualty crashes per 10M VE)	95% confidence interval	Relative risk	Crash cost rate (cents per VE)	Relative cost
URBAN		1.32	(1.21; 1.43)	3.57	1.90	1.68
RURAL		0.37	(0.33; 0.41)	1.00	1.13	1.00
URBAN	3 LEG	0.84	(0.73; 0.95)	3.65	1.16	1.59
URBAN	4 LEG	2.29	(2.04; 2.54)	9.96	3.39	4.64
RURAL	3 LEG	0.43	(0.38; 0.48)	1.87	1.29	1.77
RURAL	4 LEG	0.23	(0.17; 0.29)	1.00	0.73	1.00

Tasmania

A sample of Tasmanian crash rate information has been developed. Greater detail of attributes and results exists within the database. It is possible to perform more specific analysis on request.

Table A11: Tasmanian crash rates – road midblock stereotypes

Road stereotype		Crash rate (casualty crashes per 100M VKT)	95% confidence interval	Relative risk	Crash cost rate (cents per VKT)	Relative cost
URBAN		20.23	(18.68; 21.78)	1.20	2.91	1.00
RURAL		16.92	(16.17; 17.67)	1.00	4.60	1.58
URBAN	SINGLE	22.61	(20.21; 25.01)	2.29	3.69	2.12
URBAN	DIVIDED	18.18	(16.18; 20.18)	1.84	2.24	1.29
RURAL	SINGLE	18.96	(18.06; 19.86)	1.92	5.43	3.12
RURAL	DIVIDED	9.86	(8.66; 11.06)	1.00	1.74	1.00

Table A12: Tasmanian crash rates – intersection stereotypes

Intersection stereotype		Crash rate (casualty crashes per 10M VE)	95% confidence interval	Relative risk	Crash cost rate (cents per VE)	Relative cost
URBAN		0.85	(0.56; 1.04)	1.06	1.00	1.00
RURAL		0.80	(0.65; 1.03)	1.00	1.89	1.89
URBAN	3 LEG	0.84	(0.59; 1.09)	1.91	0.96	1.00
URBAN	4 LEG	1.51	(0.03; 2.99)	3.43	1.86	1.94
RURAL	3 LEG	0.83	(0.64; 1.02)	1.89	1.79	1.86
RURAL	4 LEG	0.44	(-0.06; 0.94)	1.00	3.25	3.39

Australian Capital Territory

Greater detail of ACT attributes and results exists within the database. It is possible to perform more specific analysis on request.

Table A13: ACT crash rates – road midblock stereotypes

Road stereotype		Crash rate (casualty crashes per 100M VKT)	95% confidence interval	Relative risk	Crash cost rate (cents per VKT)	Relative cost
URBAN		4.80	(4.34; 5.26)	1.00	1.02	1.00
RURAL		19.69	(15.48; 23.9)	4.10	5.41	5.30
URBAN	SINGLE	6.00	(5.17; 6.83)	1.49	1.26	1.48
URBAN	DIVIDED	4.04	(3.49; 4.59)	1.00	0.86	1.01
RURAL	SINGLE	20.5	(16.06; 24.94)	5.07	5.71	6.72
RURAL	DIVIDED	7.52	(-2.9; 17.94)	1.86	0.85	1.00

Table A14: ACT crash rates – intersection stereotypes

Intersection stereotype		Crash rate (casualty crashes per 10M VE)	95% confidence interval	Relative risk	Crash cost rate (cents per VE)	Relative cost
URBAN		0.62	(0.54; 0.7)	1.00	0.99	1.00
RURAL		2.47	(-0.32; 5.26)	3.98	2.78	2.81
URBAN	3 LEG	0.58	(0.48; 0.68)	1.00	0.89	1.27
URBAN	4 LEG	0.69	(0.56; 0.82)	1.19	1.16	1.66
RURAL	3 LEG	2.47	(-0.32; 5.26)	4.26	2.78	3.97
RURAL	4 LEG	0.62	(0.19; 1.05)	1.07	0.70	1.00